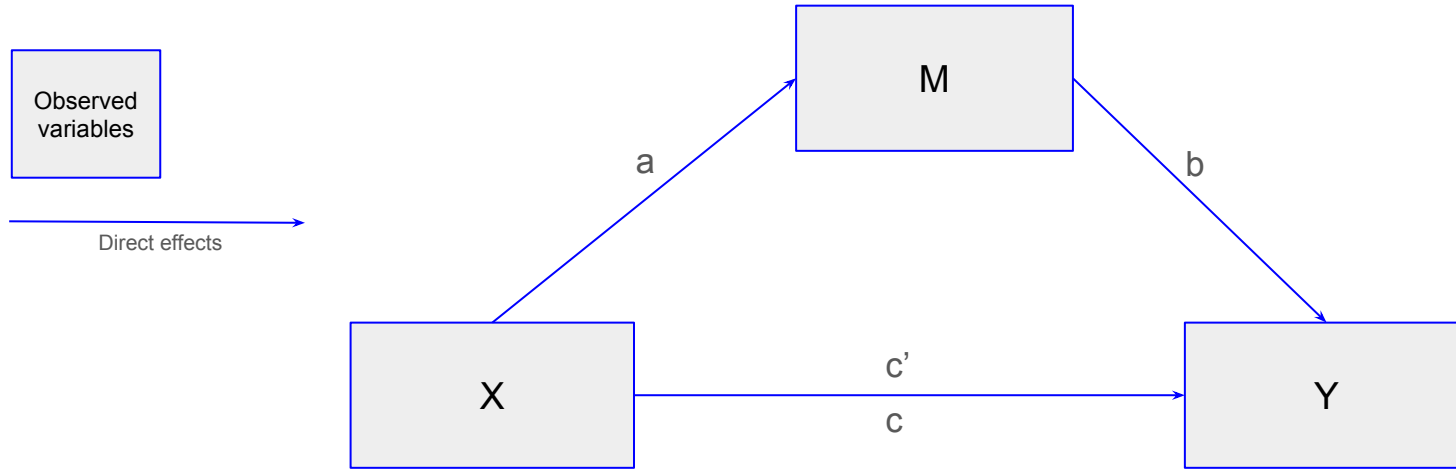


Path modeling/ Structural Equation Modeling (SEM)

Advanced Statistical Methods in Psychology

PSYCH 504 • Spring 2024
Princeton University

Last week - Mediation Model

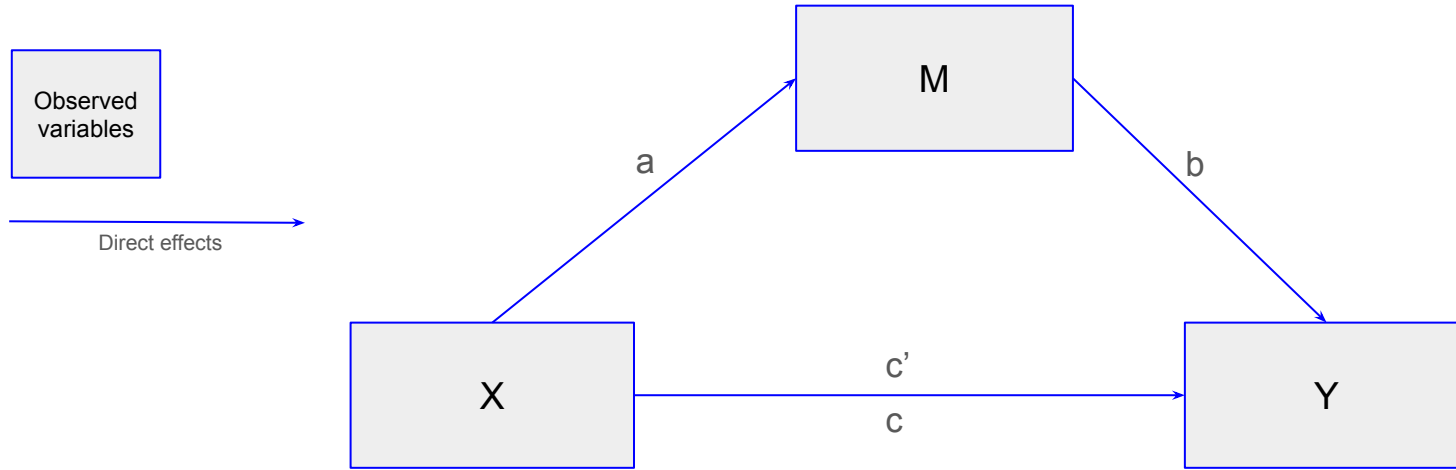


c -> **Total** effect of X on Y (also $c = c' + a*b$)

c' -> **direct** effect of X on Y controlling for M

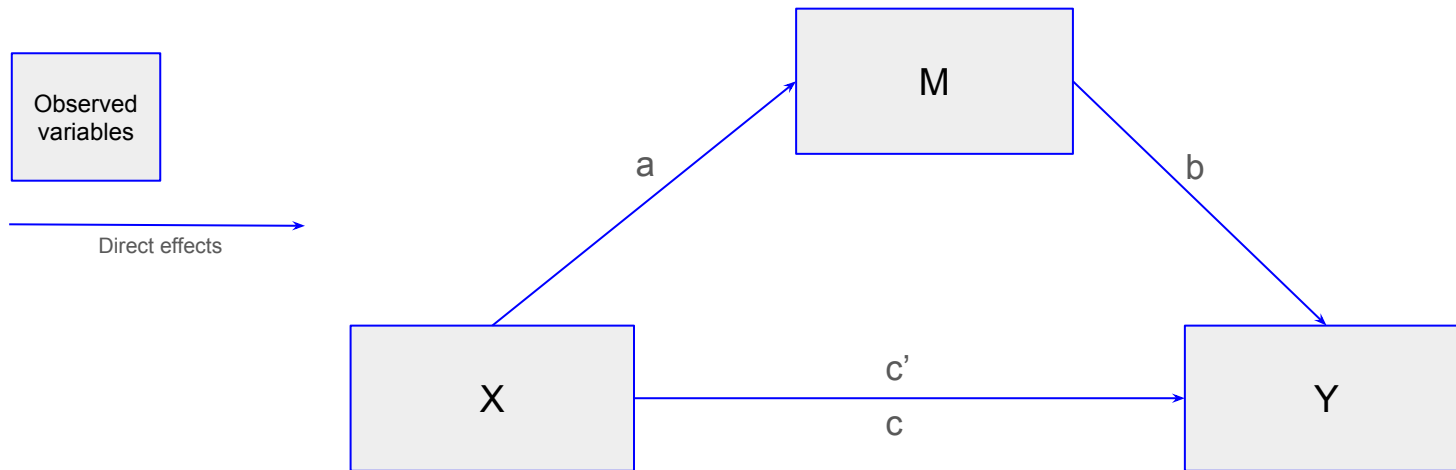
$a*b$ -> **indirect** effect of X on Y (mediated by M)

Last week



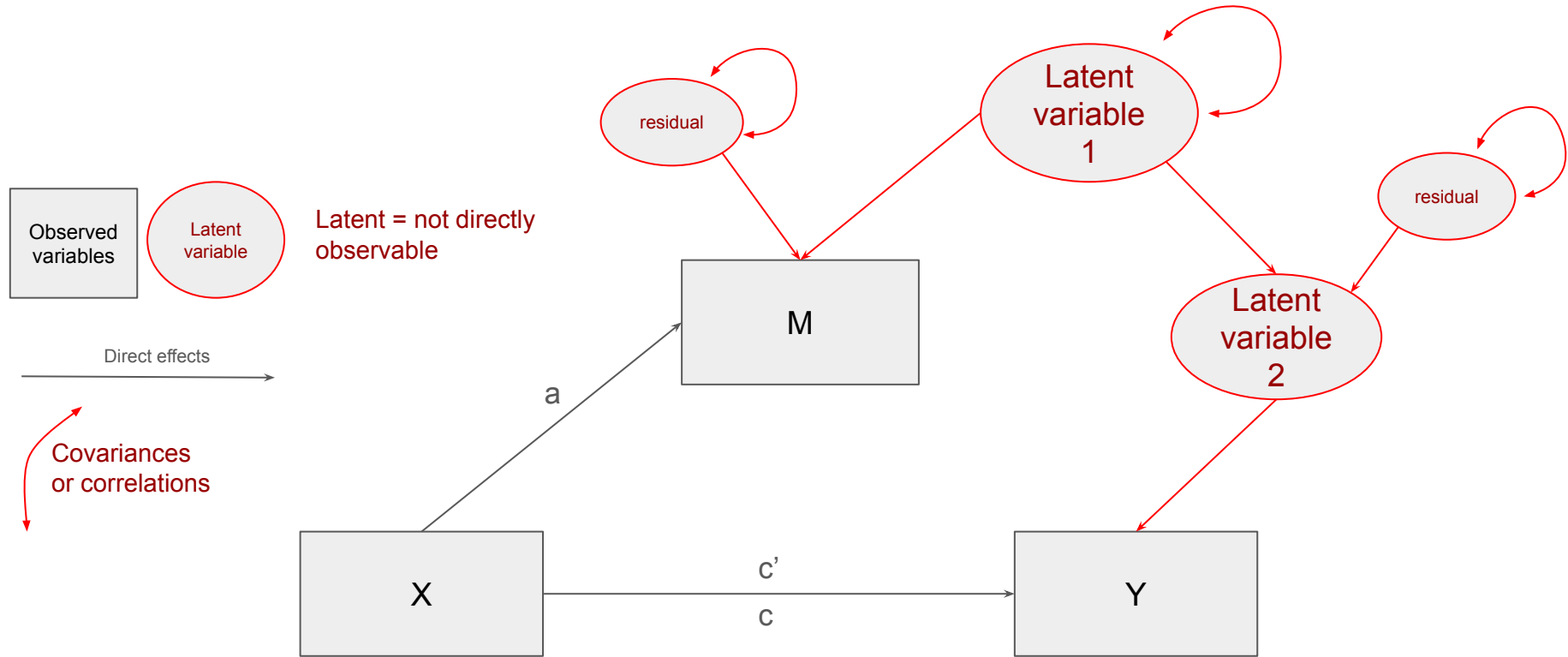
This way of modeling can be considered a special case of structural equation modeling. Which special case?

Last week



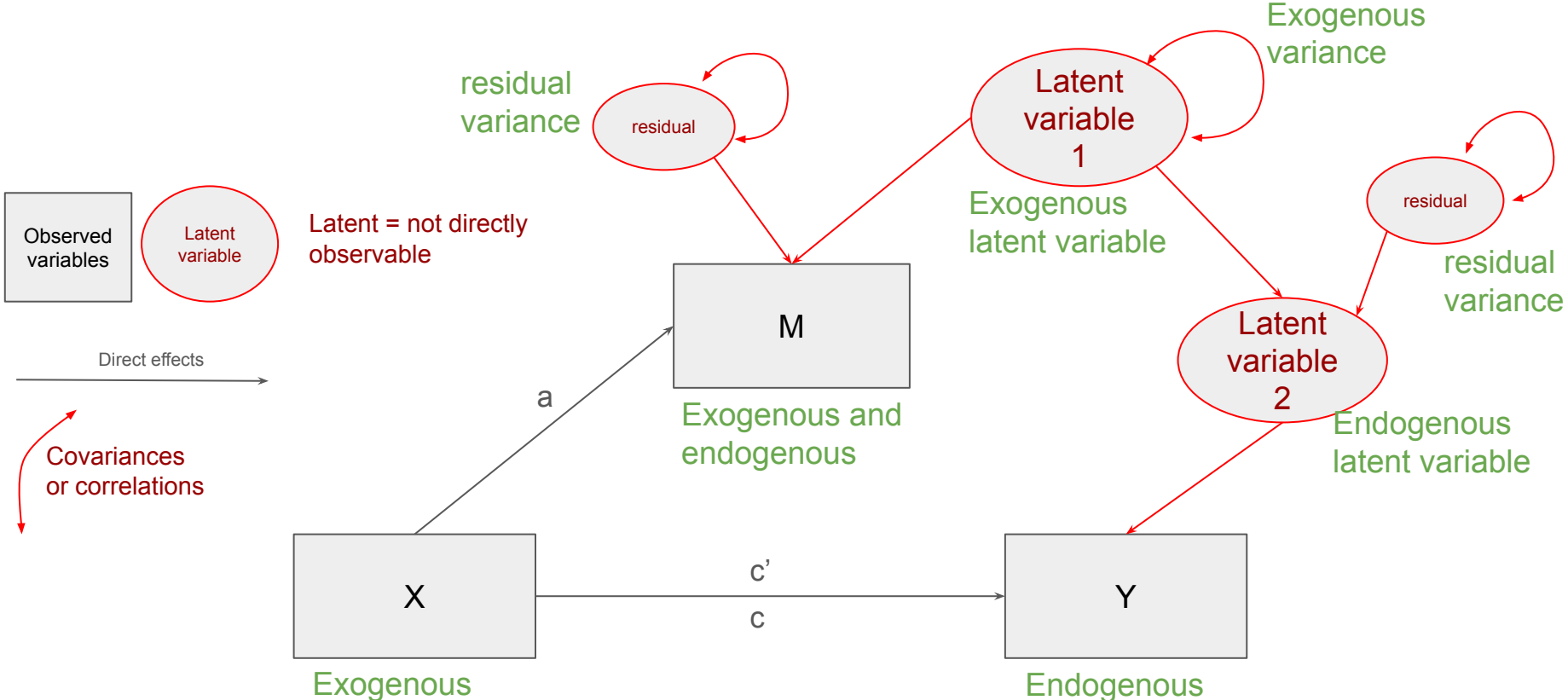
All variables are observed variables (can be measured).

Structural Equation Modeling (SEM)



Latent variables can be used to model residuals or constructs of interest that we can't directly measure

Structural Equation Modeling (SEM)

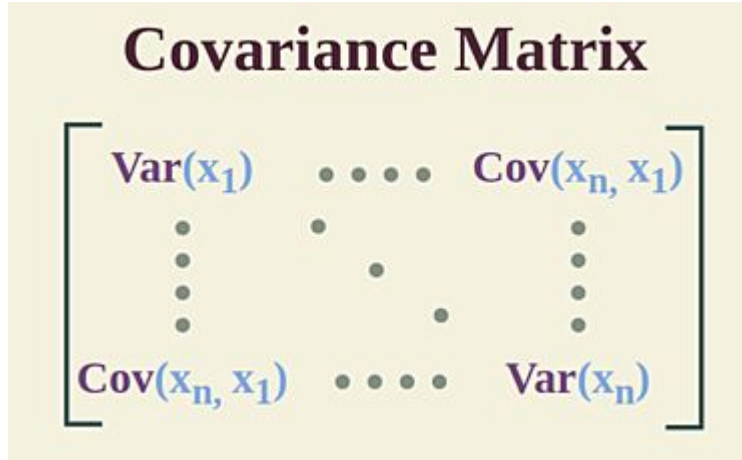


Structural Equation Modeling (SEM): specifying a complex system of predictive pathways among a large number of variables (measured or not)

- It is an extension of regression and path analysis in which **all possible relationships between variables are evaluated simultaneously.**
- It is versatile, allowing to test a variety of hypotheses that other more traditional methods do not allow.
- Allow to explicitly model and account for measurement error.
- Allow theory driven, rather only data driven analysis (using Confirmatory Factor Analysis, for example)

Covariance matrix

The covariance matrix is the sufficient statistic for SEM: it contains all the information needed to fit a standard SEM analysis



$$\text{cov}(x,y) = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{n-1}$$

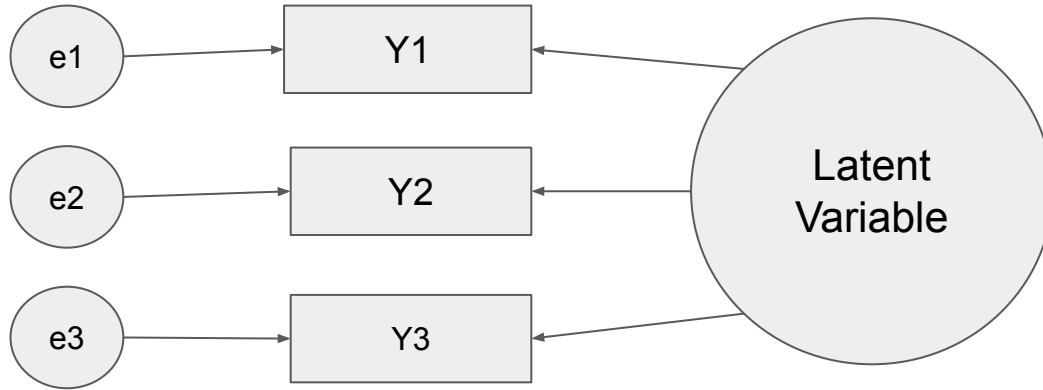
Structural Equation Modeling (SEM): specifying a complex system of predictive pathways among a large number of variables (measured or not)

1. Measurement Model
2. Structural (Path) Model

Measurement Model

The relationship between an exogenous latent variable and measured variables only

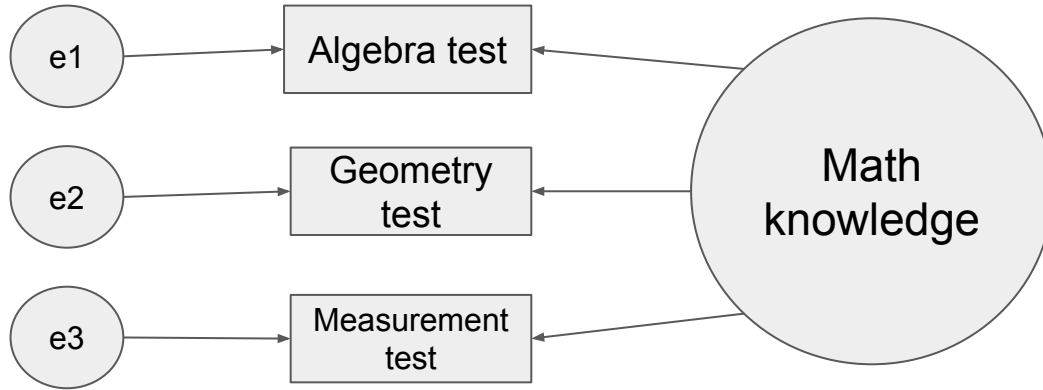
- Generally used when describing a confirmatory factor analysis



Measurement Model

The relationship between an exogenous latent variable and measured variables only

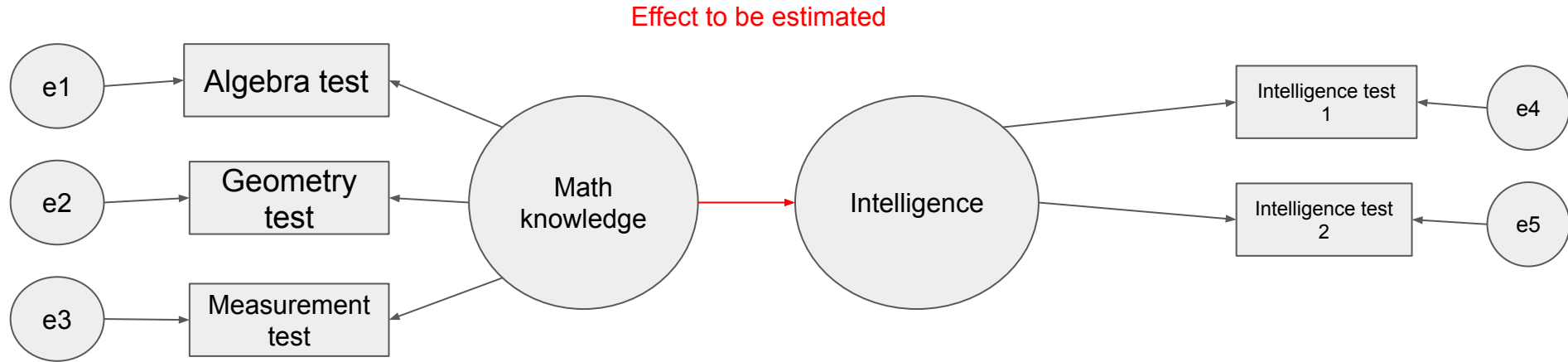
- Generally used when describing a confirmatory factor analysis



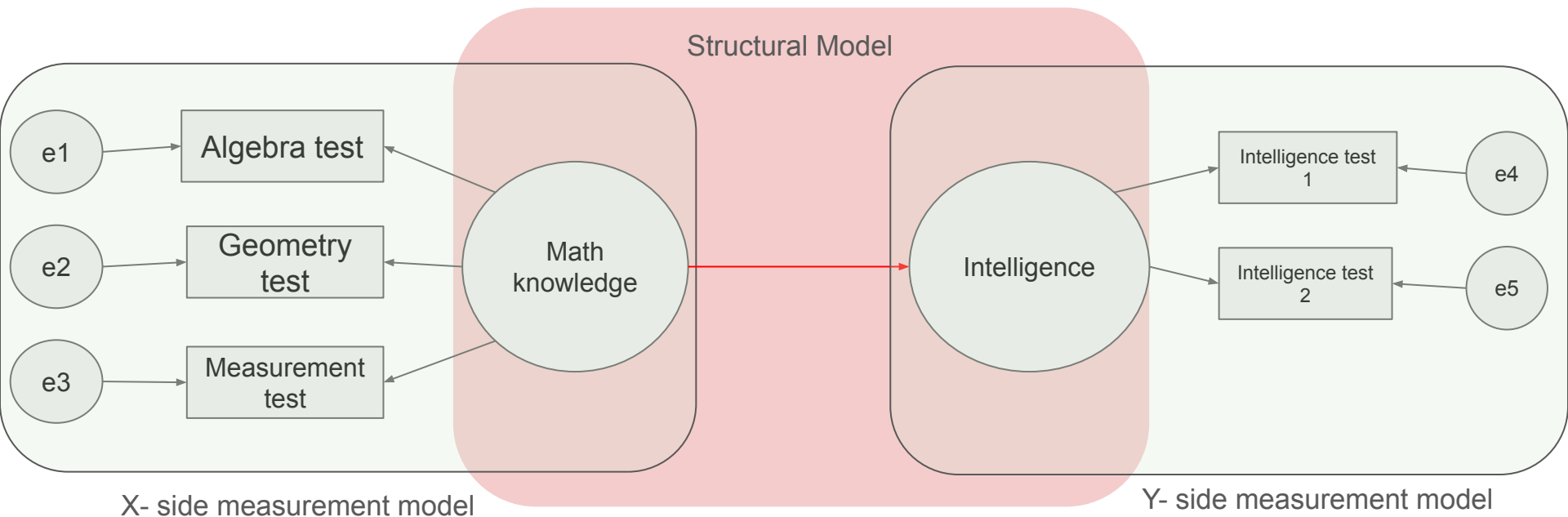
Structural (Path) Model

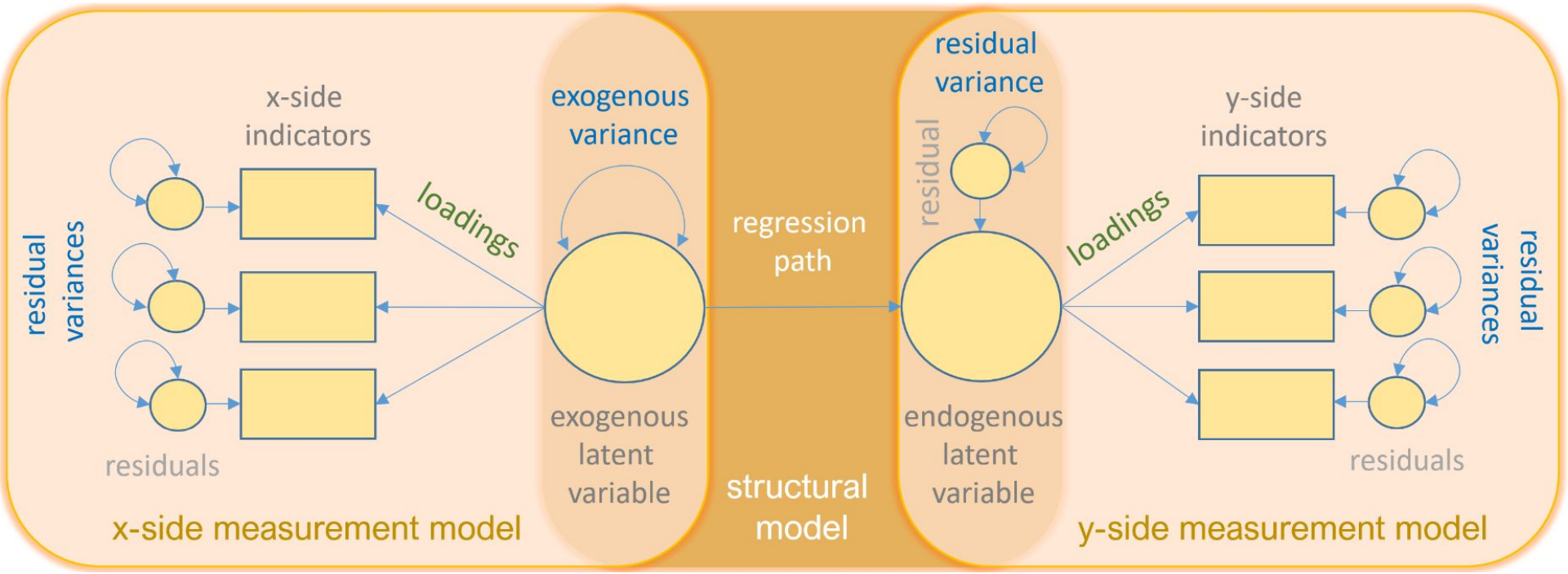
Relationship between various constructs of the model.

- Generally used specify how latent variables directly or indirectly affect other latent variables in the model



Structural (Path) Model

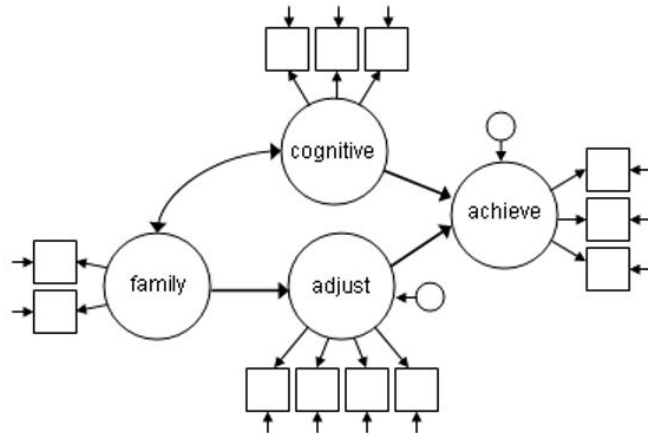




Procediment

1. Specification - How we draw the model?

Equations, independent variables, dependent variables, mediators, moderators, latent factors...



Procediment

1. Specification
2. Identification - Do you have enough information in your data to estimate the number of parameters you want to estimate?

Procediment

1. Specification
2. Identification
3. Estimation - Which method are you using? (Maximum likelihood, ...)

Procediment

1. Specification
2. Identification
3. Estimation
4. Evaluation - How well the proposed model fits the data?

Procediment

1. Specification
2. Identification
3. Estimation
4. Evaluation
5. Respecification (if necessary)
 - a. If the model doesn't fit well, what modifications the data suggest?

Procediment

1. Specification
2. Identification
3. Estimation
4. Evaluation
5. Respecification (if necessary)
6. Interpretation